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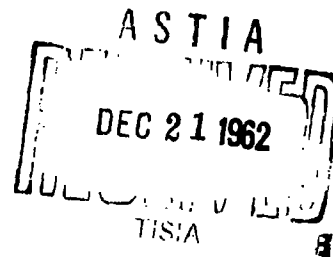
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# PARASITOLOGICAL FACTORS IN THE NATURAL FOCI OF TAIGA ENCEPHALITIS

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U.S. ARMY BIOLOGICAL LABORATORIES  
FORT DETRICK, FREDERICK, MARYLAND

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PARASITOLOGICAL FACTORS IN THE NATURAL

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by Ye. N. Pavlovskiy

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## PARASITOLOGICAL FACTORS IN THE NATURAL FOCI OF TAIGA ENCEPHALITIS

[ Following is a translation of an article by Ye. N. Pavlovskiy in Zoologicheskii Zhurnal (Zoological Journal), Vol 19, No 2, 1940, pages 333-335. ]

(Expeditions of the People's Commissariat of Health USSR, 1938-1939)

Parasitology department of the VIEM im. Gor'kogo [ All-Union Institute of Experimental Medicine imeni Gor'kiy) and the chair of general biology and parasitology of the Military Medical Academy RKKA im. Kirova [ Workers' and Peasants' Red Army imeni Kirov]

The work of the expedition of the Narkomzdrav [ People's Commissariat of Health] USSR in 1938 on taiga encephalitis (head of the expedition -- Academician Ye. N. Pavlovskiy, deputy chief, Professor A. Smorodintsev; commissar of the expedition, Military Physician M. D. Kashirin) led to determination of the role played by various species of pasture ticks in the transmission of the pathogens of this disease. *Ixodes persulcatus* and *Haemaphysalis concinna* ticks spontaneously infected with the virus were encountered both in the unfed state in nature and on various wild and domestic animals. On the basis of the totality of work of the 1938 expedition the idea was gained that there are foci of the taiga encephalitis [ tick-borne spring-summer encephalitis] virus in the wild nature of the taiga [ spruce and fir forests of the temperate zone].

This situation was expressed by the author both in accounts of the expedition and in reports. The schema of the virus circulation in such a focus was constructed on the basis of the parasitological interrelationships of pasture ticks and rodents (particularly chipmunks).

The detachment of the 1939 Narkomzdrav expedition headed by the author (chief, Military Physicians 1st Rank L. Rogozin; commissar, M. D. Kashirin, and workers of the Zoological Institute of the Academy of Sciences, the VIEM imeni Gor'kiy, and the Military Medical Academy RKKA imeni Kirov) was confronted with the problem of further and subsequent detailed analysis of the natural focalization of taiga encephalitis, further study of the tick vectors of the virus, and methods of controlling them.

The work was developed in two places: at the Suputinsk Zapovednik [National Forest] (wild taiga) and on the territory of the Gornotaiga Station (GTS) of the Academy of Sciences USSR in Ussuriyskaya Oblast (inhabited taiga).

Study of *Ixodes persulcatus* from the national forest in the first half of the summer showed the great extent of spontaneous infection of them with the encephalitis virus; thereby, in the depths of the national forest (the region of Yegerskiy Klyuch [spring]) the infection was much more extensive than in the region of the inhabited portion of the national forest. On the territory of the GTS not a single virus-infected tick was found (Ryzhov, Kozlova with the participation of Serdyukova).

Similar results were given by the study of wild animals for carriage of the encephalitis virus. Not a single virus strain was isolated from 274 rodent specimens of four species caught by P. Grachev on the territory of the GTS or from two hedgehogs and three wolf cubs caught by V. Solov'yev; on the other hand, from 399 specimens of rodents, insectivores and carnivores from the national forest (caught by Nadetskiy and hunters) virus strains were obtained from the brains of moles (*Mogera robusta*), hedgehogs (*Erinaceus amurensis*) and bank voles (*Evtomys rufocanus*).

Experimentally it was possible to infect wolf cubs and hedgehogs from the GTS territory with encephalitis; they gave the characteristic picture of the disease (V. Solov'yev). These data, as well as material on the hosts of the tick vectors of the encephalitis virus and on spontaneous infection of the ticks have considerably extended our ideas about the group of mammals which can play a part of transmitters in the process of the virus circulation in the natural focus of encephalitis.

The 1939 studies emphasize even more the specific part played by pasture ticks as vectors of the encephalitis virus; of the new facts we can even now mention the following:

1. Kozlova and Solov'yev (VIEM) proved the part played by



*Haemaphysalis concinna* as a virus vector during the course of metamorphosis and transmission of the virus from the experimentally-infected female to its progeny by way of transovarial infection.

2. Pavlovskiy and Solov'yev studied the routes of the virus circulation in the bodies of experimentally-infected *Ixodes persulcatus* female ticks. Emulsions from all the organs, with the exception of the chitin and fat body with the subcuticula, caused a paralytic disease when mice were infected with it for the first time, whereby emulsions from the salivary glands and intestine maintained this property even in the sixth dilution. Comparing these data with the work of the same authors done with *H. concinna*, it may be stated that the bodies of *H. concinna* and *I. persulcatus* ticks represent different habitats for the encephalitis virus.

3. For the first time *Dermacentor silvarum* ticks were found spontaneously infected with encephalitis viruses (Ryzhov and Kozlova according to Chagin's material).

4. It was proved that the encephalitis virus spends the winter in *I. persulcatus* ticks (Ye. Levkovich (Professor Smorodintsev's detachment) and A. Skrynnik (the author's detachment)).

5. The periods of preservation of the encephalitis virus in *D. silvarum* ticks which had been determined in 1938 -- up to 16 months -- and in *H. concinna* ticks -- up to 12 months -- were far exceeded.

6. When allowed to feed on white mice, virus-bearing ticks can cause them to be actively immunized against subsequent infection with lethal doses of the virus (experiments of the same authors with "pre-epidemification") instead of a case of encephalitis in the mice, depending on the number of ticks and the duration of feeding.

7. Cases where mice, infected intracerebrally with an emulsion of various organs of experimentally-infected *I. persulcatus* ticks did not become sick but rather acquired immunity (Pavlovskiy and Solov'yev) are in full agreement with these data. These facts throw light on the condition in which the encephalitis virus is in the various organs of the tick vector.

There should be no doubt of the fact that identical relations may be observed also in people depending on: a) the number of virus-bearing ticks which attack them, b) the degree of infection of the latter with the encephalitis virus, c) the condition of the virus in the ticks at the given moment, d) the time for which the ticks suck the person's blood (with which the quantity of virus-bearing saliva inoculated is connected), e) the condition of the organism of the person himself (the degree of resistance), and f) the effect of environmental factors on the process of transmission and reception of the virus.

These considerations have been proved by Solov'yev's data, who found a large quantity of antibodies against the encephalitis virus in the

sera of people and cattle in the national forest and the opposite situation on the territory of the GTS. The Lespromkhoz base, located almost between these two points, showed the picture of a kind of intermediate state.

The national forest is a classic natural focus of spring-summer encephalitis; cases among people have been observed in it.

When several species of ticks are present -- vectors of the encephalitis virus -- the question of the epidemiological roles of the different species arises. For each species of tick it depends primarily on the significance of the given species in the matter of maintaining the natural focus of virus encephalitis (transmission of the encephalitis virus by a tick from a donor to a recipient animal), and on the degree to which the virus can be transmitted by the ticks to their own progeny during the course of transovarial infection, the frequency with which the ticks are parasitic on donor hosts, on the group of the ticks' hosts, and on the census of possible recipient hosts, and others.

With respect to man the epidemiological significance of the tick species is determined by the frequency of attacks, the ease of infection of man, and by the factors accounting for the reverse process, that of immunization, instead of infection.

The existing data indicate the great frequency with which man is attacked by *I. persulcatus* ticks, which, like *H. concinna*, can attack not only in the adult but also in the nymph stages.

As the result of the structural characteristics of the oral organs of *I. persulcatus* it more easily and more deeply embeds itself in a person's skin than, for example, *H. concinna*. As yet, there are few such observations on the earliest *D. silvarum* tick, but this tick can also bite man.

### Abstract

This work was done in two places: inhabited and wild taiga. In the former, studies of *Ixodes persulcatus* ticks for the virus of spring-summer (taiga) encephalitis were all negative; in the latter, extensively positive. The same applied to the mammalian hosts. *Haemaphysalis concinna* ticks were shown to be virus vectors from nymph to adult stages and to transmit the virus transovarially to their progeny. Spontaneously infected *Dermacentor silvarum* ticks were also found. Mice can be infected with emulsions of *I. persulcatus* organs or may, instead, become immune. The same alternatives hold in the case of infected tick bites. Which of the two occurs depends on the quantity of virus inoculated, which, in turn, is related to the number of ticks biting, the degree to which they are infected, the duration of blood-sucking; also important here are the conditions of the virus, the environment and the animal. There is no doubt that the same factors operate when man is bitten by infected ticks. The fact that high serum antibody titers are found in man and cattle in the wild taiga, low titers in the inhabited taiga, and an intermediate situation at a place between the two is cited as proof.

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